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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/675,627	09/29/2000	Michael Rumer	M-8570 US	9578

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EXAMINER

PERKINS, PAMELA E

ART UNIT

PAPER NUMBER

2822

DATE MAILED: 01/31/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/675,627

Applicant(s)

RUMER ET AL.

Examiner

Pamela E Perkins

Art Unit

2822

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 29 September 2000.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-22 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-22 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 29 September 2000 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

Art Unit: 2822

DETAILED ACTION

This office action is in response to the filing of the application papers on 29 September 2000. Claims 1-22 are pending.

Drawings

The drawings are objected to because under 37 CFR 1.84(k) all drawings must be made by a process which will give them satisfactory reproduction characteristics. Every lines, number, and letter must be durable, clean, black (except for color drawings), sufficiently dense and dark, and uniformly thick and well-defined. The weight of all lines and letters must heavy enough to permit adequate reproduction. Correction is required. The objection to the drawings will not be held in abeyance.

Claim Objections

Claims 18 and 20 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. The depending claim is identified in the body of the dependent claim and not in the preamble.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

Art Unit: 2822

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-3, 9, 10 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hartig et al. (5,427,665) in view of Shinriki et al. (6,063,703).

Referring to claim 1, Hartig et al. disclose placing a substrate (1) in a process chamber (15) and depositing a predominantly metallic layer (2) on the substrate by sputtering (col. 2, lines 56-67; col. 3, lines 1-43; Fig. 1). Hartig et al. do not disclose hydrogen in the atmosphere of the process chamber, for preferred crystal orientation. Shinriki et al. disclose a method of forming a metal interconnect (14) by sputtering on a substrate (11) where hydrogen is in the atmosphere (col. 8, lines 47-58 & 66-67; col. 9, lines 1-11). It would have obvious to one of ordinary skill in the art at the time the invention was made to modify Hartig et al. by having hydrogen in the atmosphere as taught by Shinriki et al. because under such conditions the deposited layer has a preferential crystal orientation.

Referring to claims 2, 3, 9, 10 and 18, Hartig et al. disclose placing a substrate (1) in a process chamber (15) and depositing a predominantly metallic layer (2) on the substrate by sputtering. Hartig et al. further disclose a target (3) to be sputtered opposite the substrate (1) when power is supplied to the target (3) from a voltage source (10) (col. 2, lines 56-67; col. 3, lines 1-43; Fig. 1). Hartig et al. do not disclose the metal layer comprising titanium or aluminum. Shinriki et al. disclose a method of forming a metal interconnect (14) by sputtering on a substrate (11) where hydrogen is in the atmosphere (col. 8, lines 47-58 & 66-67; col. 9, lines 1-11). Shinriki et al. further

Art Unit: 2822

disclose the interconnect (14) comprising a titanium layer (17) of preferential orientation formed over the substrate (11) a titanium nitride layer (15) of preferential orientation formed over the titanium layer (17) and a aluminum layer (16) of preferential orientation also formed over the titanium layer (17) (col. 2, lines 15-21; col. 9, lines 21-54). It would have obvious to one of ordinary skill in the art at the time the invention was made to modify Hartig et al. by depositing a metal layer comprising titanium, aluminum or titanium nitride as taught by Shinriki et al. The use of titanium, aluminum or titanium nitride as the metal layer improves the reliability as well as electromigration immunity in semiconductor devices.

Claims 4, 11-14, 20 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hartig et al. in view of Shinriki et al. as applied to claims 1-3, 9, 10 and 18 above, and further in view of Miyasaka (6,124,154).

Hartig et al. disclose placing a substrate (1) in a process chamber (15) and depositing a predominantly metallic layer (2) on the substrate by sputtering, a target (3) to be sputtered opposite the substrate (1) when power is supplied to the target (3) from a voltage source (10). Hartig et al. further disclose a first gas injector (20) positioned proximate to the target (3) and a second gas injector (21) (col. 2, lines 56-67; col. 3, lines 1-43; Fig. 1). Hartig et al. do not disclose the first gas injector introducing argon and hydrogen, the second gas injector introducing an inert gas. Miyasaka discloses a method of forming a thin film over a substrate (10) in an atmosphere on hydrogen in argon with an inert gas (col. 5, lines 57-67; col. 6, lines 1-25). It would have obvious to one of ordinary skill in the art at the time the invention was made to modify Hartig et al.

Art Unit: 2822

by the first gas injector introducing argon and hydrogen, the second gas injector introducing an inert gas into the atmosphere as taught by Miyasaka because under such conditions the semiconductor atoms are easily scattered to produce high purity layers.

Claims 5 and 8 rejected under 35 U.S.C. 103(a) as being unpatentable over Hartig et al. in view of Shinriki et al. as applied to claims 1-3, 9, 10 and 18 above, and further in view of Cava et al. (5,473, 456).

Hartig et al. disclose placing a substrate (1) in a process chamber (15) and depositing a predominantly metallic layer (2) on the substrate by sputtering. Hartig et al. further disclose a target (3) to be sputtered opposite the substrate (1) when power is supplied to the target (3) from a voltage source (10) (col. 2, lines 56-67; col. 3, lines 1-43; Fig. 1). Hartig et al. do not disclose at least 0.1 molar percent of hydrogen in the atmosphere. Cava et al. disclose forming a layer over a substrate (13) in a sputtering chamber (11) with a target (10) in atmosphere that contains 15 mole percent hydrogen (col. 2, lines 63-67; col. 3, lines 1-44). It would have obvious to one of ordinary skill in the art at the time the invention was made to modify Hartig et al. by having 15 mole percent hydrogen in the atmosphere as taught by Cava et al. because the layer formed have good electrical conductivity.

Claims 6, 7, 16 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hartig et al. in view of Shinriki et al. and Miyasaka as applied to claims 1-4, 9-14, 20 and 21 above, and further in view of Kaloyeros et al. (6,139,922).

Art Unit: 2822

Hartig et al. disclose placing a substrate (1) in a process chamber (15) and depositing a predominantly metallic layer (2) on the substrate by sputtering. Hartig et al. further disclose a target (3) to be sputtered opposite the substrate (1) when power is supplied to the target (3) from a voltage source (10) (col. 2, lines 56-67; col. 3, lines 1-43; Fig. 1). Hartig et al. do not disclose provide power to the target with a power density of 3 to 8 watts per square centimeter. Kaloyeros et al. disclose a method of forming a film over a substrate by a method of sputtering. Kaloyeros et al. further disclose the power used in the sputtering method having a power density of between 0.01 W/cm^2 and 10 W/cm^2 (col. 10, lines 60-67; col. 11, lines 1-17). It would have obvious to one of ordinary skill in the art at the time the invention was made to modify Hartig et al. by applying powering to the target with a power density of 0.01 W/cm^2 to 10 W/cm^2 as taught by Kaloyeros et al. Under such conditions undesirable film contamination and electrical damage to the film are prevented.

Claims 19 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hartig et al. in view of Shinriki et al. and Miyasaka as applied to claims 1-4, 9-14, 20 and 21 above, and further in view of Hsu et al. (6,329,282).

Hartig et al. disclose placing a substrate (1) in a process chamber (15) and depositing a predominantly metallic layer (2) on the substrate by sputtering. Hartig et al. further disclose a target (3) to be sputtered opposite the substrate (1) when power is supplied to the target (3) from a voltage source (10) (col. 2, lines 56-67; col. 3, lines 1-43; Fig. 1). Hartig et al. do not disclose the aluminum layer with a full width at half maximum (FWHM) x-ray diffraction signal of less than about 1.5 degrees. Hsu et al.

Art Unit: 2822

disclose a method of forming an titanium (9), titanium nitride (11), aluminum (19) interconnect. Hsu et al. further disclose the aluminum layer having a FWHM of 1.5 degrees (col. 3, lines 11-65). It would have obvious to one of ordinary skill in the art at the time the invention was made to modify Hartig et al. by the aluminum layer having a FWHM of 1.5 degrees as taught by Hsu et al. because it improve the crystallographic orientation of the aluminum layer.

Hsu et al. do not disclose the aluminum layer having a FWHM of less than 1.5 degrees. It would have been obvious to one having ordinary skill in the art at the time invention was made to have a FWHM of less than 1.5 degrees for the aluminum layer, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233 (CCPA 1955).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Pamela E Perkins whose telephone number is (703) 605-4299. The examiner can normally be reached on Monday thus Friday, 8:30am to 5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on (703) 308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are (703)

Art Unit: 2822

305-3432 for regular communications and (703) 305-3432 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

pep
January 25, 2002

A handwritten signature in black ink, reading "Carl Whitehead, Jr." with a stylized flourish at the end.

**CARL WHITEHEAD, JR.
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800**